TECH 4 TRACING

Bringing New Tech to Arms Control

T4T Report from UN PoA BMS8

Key findings

- The UN PoA/ITI process has been slow to consider the use of new technologies ('new tech') to enhance efforts to address illicit small arms proliferation.
- Technology-related discussion in UN PoA/ITI forums has focused narrowly on addressing marking and tracing challenges presented by new small arms manufacture and designs.
- New technology products currently under development offer opportunities to enhance PoA/ITI-related arms controls, including for diversion prevention; supply chain monitoring; arms and ammunition identification and tracing in conflict and crime contexts; peacekeeping intelligence; investigations into human rights abuses and international humanitarian law (IHL) violations; among other initiatives and processes.
- The combination of computer vision technology for the automated detection of arms and ammunition items, which is now approaching full feasibility, and machine learning techniques for recognizing, cataloguing, and sharing data extracted from firearms and ammunition, opens the door for these technologies to be used in a range of operational contexts.
- A robust discussion among arms control practitioners, new technology specialists, and national authorities is now needed to identify promising entry points and opportunities for innovative applications across weapon systems, political processes, and operational environments.
- Policymakers and technical experts need to consider reservations that developing states have expressed about how the 'digital divide' will affect the equitable implementation of new tech solutions for arms control—as well as the potential negative consequences of disseminating arms detection algorithms.

Introduction

During the Eighth Biennial Meeting of States (BMS8) to consider implementation of the UN Programme of Action to Prevent, Combat and Eradicate the Illicit Trade in Small Arms and Light Weapons in All Its Aspects (PoA) and the International Tracing Instrument (ITI), states once again highlighted 'the opportunities and challenges related to recent developments in small arms and light weapons manufacturing, technology and design'[1] for PoA and ITI implementation. While it was hoped that this call would lead to a decision to establish the long-anticipated Open-ended Technical Expert Group to consider these issues in earnest, in the end BMS8 decided to put it on the agenda of the Fourth Review Conference in 2024. In the best-case scenario, the work of the expert group would begin in 2025.

Image 1. Sample video showing a simple 3D rendered scene with the 9N235 submunition.
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The discussion around the establishment of this expert body points to the way that states have approached new technologies in the PoA/ITI forum, i.e. as a problem rather than as a solution. In this case the problem is how to effectively apply ITI marking requirements to modular, polymer, and 3D-printed firearms—an issue that has been under discussion within the PoA/ITI process since 2011.[2] At BMS8 some delegations blocked plans to advance the issue once again because, in their own words, they do not have the technical expertise to effectively engage in conversations about the policy implications of these new developments, and they prefer not to cede the discussion to a small group of technologically advanced states.

Meanwhile, BMS8 missed another chance to stimulate a conversation about the opportunities that new technologies present for enhancing the implementation of small arms and light weapons controls. This broader theme was the subject of a

BMS8 side event on 29 June 2022 organized by Tech 4 Tracing (T4T) with the support of the Permanent Missions of Belgium and Mexico to the United Nations (see Image 2). The side event provided member states ' and UN agencies with expert perspectives on the application of new technologies to a range of arms control challenges, as well as opportunities for lowering the costs of more effective illicit arms monitoring in both crime- and conflict-affected contexts. The key messages and findings of this event are reported here.

Framing new tech in arms control processes

The developments at BMS8 underscore a number of observations about the framing of new technologies in arms control processes. First, the pace of discussions has been very slow. As noted, polymer and modular weapons have been on the PoA/ITI agenda for more than ten years, and 3D-printed weapons ('additive manufacture') have still not been directly addressed at the global policy level. Ten years is nearly a generation in terms of technological development, and by the time the proposed expert group begins its work in 2025 there will undoubtedly be new technological developments to consider.

Second, discussions have tended to focus narrowly on technological advances in weapons development and how existing frameworks like the PoA/ITI might be modified or extended to cover them. So, while language on the need to consider both the 'challenges and opportunities' of new technologies is frequently found in PoA/ITI process outcome documents, the emphasis is almost exclusively on dealing with the new challenges that have arisen rather than on developing or applying new technologies for enhancing control opportunities.

Third, while new technological advances offer possible monitoring solutions for a range of weapon systems, in the policy domain these weapons are addressed in different forums: the UN PoA/ITI covers small arms and light weapons, but not ammunition; the Firearms Protocol of the UN Convention against Transnational Organized Crime covers firearms (and their ammunition); the Arms Trade Treaty covers conventional arms and their ammunition; the Ottawa Treaty covers anti-personnel landmines; and the Convention on Cluster Munitions covers cluster munitions. While there are important historical and policy reasons for these different forums, their separation prevents stakeholders from recognizing the control applications that new technologies can offer across the wide range of weapons systems. Yet many of the same operational actors—law enforcement, peacekeepers, humanitarian mine action actors, and human rights investigation teams—struggle with the full range of these weapons.

Image 2. T4T BMS8 side event, 29 June 2022. © T4T 2022

The following sections briefly describe two technologies currently under development by T4T and its partner VFRAME that have broad application to a number of weapons systems and with relevance to multiple policy processes. These are computer vision for the automated identification of explosive ordnance, and the automated identification of small calibre ammunition. Ultimately, it will be possible to combine these two technologies, creating a powerful new means of implementing national, regional, and global arms control commitments, including the PoA/ITI.

Computer vision for explosive ordnance objects

Computer vision technologies offer game-changing opportunities for the automated identification of weapons and ammunition objects in a variety of settings, ranging from photo archives, online platforms, and social media to live field-based applications using drones and computer-vision-aided devices.

This technology can facilitate the safe and reliable identification of diverted and prohibited weapons systems, or systems located in prohibited areas (such as those subject to a ceasefire or demobilization). The main challenge for developing this technology has historically been that of generating synthetic data to train the detection models to achieve a reliable level of accuracy. This challenge is now overcome.

In early 2022, VFRAME, an organization researching and developing state-of-the-art computer vision technologies for application to human rights research and conflict zone monitoring, partnered with T4T to gain direct access to examples of free-from-explosive ordnance in order to develop a reliable system for scanning and documenting such ordnance.[3] As a result of this access, VFRAME was able to generate high-resolution photo-realistic 3D models of the 9N235/210 cluster submunition (see Images 1 and 3) that significantly improved the volume and quality of the synthetic data needed to train the detection model to achieve the required high degree of accuracy. For the initial project, the 9N235/210 munition was selected because of its use in ongoing conflicts and because a working object detector would have immediate real-world applications. The process is feasible for any visually unique weapon or munition item.

The models were used to render synthetic training datasets for developing object detection algorithms. The 3D environment was then manipulated to change the lighting conditions and degree of camera zoom, alter the terrain, or simulate dirt and corrosion. Rendered synthetic data was automatically annotated, saving huge amounts of time compared to conventional manual image annotation.

Image 3. Rendering of various 9N235 3D models for synthetic training data and 3D printing. © Adam Harvey / VFRAME.io 2022

VFRAME now considers the detection accuracy of this algorithm to exceed the acceptable threshold for use.[4] The final 9N235 computer vision detection model is tentatively scheduled for release in September 2022, and, under an open-source MIT licence, will be available to qualified human rights and humanitarian actors and open-source intelligence researchers for use in helping to sift the vast amounts of data being generated in conflict zones.[5] Having demonstrated the feasibility of this process, scanning and generating detection algorithms for other objects of special concern would be the next step, pending donor support.

Automated small calibre ammunition identification

Another new tech application, under development by T4T, focuses on the automated identification of small calibre ammunition recovered in the contexts of crime and conflict. Currently, public and private actors involved in the monitoring of illicit arms and ammunition trafficking must manually enter headstamp-associated data for recovered ammunition at scenes of violence, which is extremely time consuming given the volume of shell casings observed in the field. In June 2021 T4T began work on an ammunition identification tool incorporating optical character recognition (OCR), machine learning, and artificial intelligence. The resulting tool will automatically extract ammunition headstamp data and compare it to user-generated baseline datasets (see Figure 1 and Image 4). When combined with geo-analytics and other intelligence tools in one application, an associated platform will allow users to identify patterns of ammunition use, misuse, and trafficking.

In early June 2022 the UN Trust Facility Supporting Cooperation on Arms Regulation (UNSCAR) awarded T4T a grant to develop the ammunition headstamp tool and associated dataset platform.

As of August 2022 T4T has developed an online annotation tool that allows users to train the OCR headstamp data extraction tool. Once this tool has been sufficiently

trained, it will be incorporated into a mobile application. In addition to a public version of this platform that will be made available to expert and amateur users, proprietary versions will be developed to allow agencies, institutes, and international organizations to develop their own ammunition datasets, which can then be kept securely within their own institutions.

One important application of this technology will be for enhancing the collection of evidence in cases of criminal violence and possible human rights abuses and IHL violations. This requires rigorous legal standards for the handling of both physical and digital evidence to be built into the platform.

Getting serious about new tech and arms control

New technologies such as computer vision, OCR and machine learning, and artificial intelligence have wide-ranging possible applications to arms control. They include weapons and ammunition management, including diversion prevention; supply chain monitoring; arms and ammunition identification and tracing in conflict and crime contexts; peacekeeping intelligence; and investigations into human rights abuses and IHL violations, including treaty compliance. These applications cut across weapons systems and policy processes.

The benefits for monitoring and investigation may be particularly rich in cases where concerns about data and evidence protection and chain of custody are paramount. They are also advantageous for ceasefire monitoring and verification or other arms control tasks, allowing remote detection (e.g. with drones) in conflict zones where physical inspection is too dangerous. While this list of applications is only indicative, it suggests that thinking about applications should be framed in the broadest possible terms, not narrowly, and should consider a wide range of domains, processes, and needs.

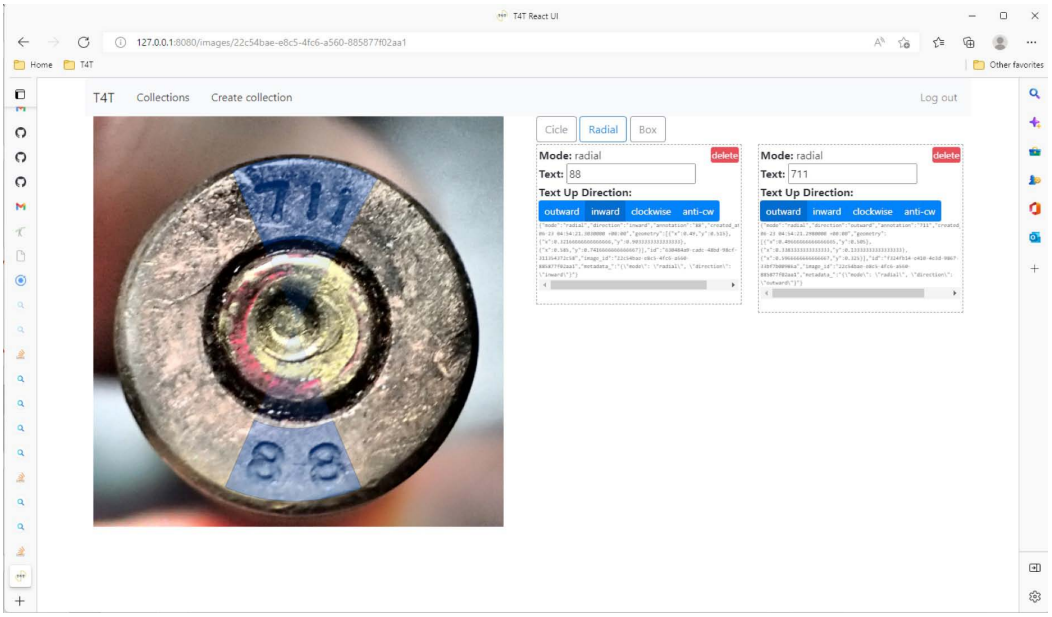
Technology is not a panacea, however, and plans for the adoption of new technology in arms control must remain rooted in the real world. It will be essential to address the relative availability of technical expertise; data collection, management, and information-sharing systems; and data security within and between authorities. This means that operational actors need to be engaged

Figure 1. Ammunition Assessment and Analysis for Criminal and Defence Intelligence

now so that they can consider how these aspects can be adequately addressed in future solutions. How will peacekeepers adopt and integrate computer vision detection of illicit arms into their technical intelligence platforms? How can law enforcement agencies integrate OCR-based systems for small calibre ammunition into their evidence in ways that make the data admissible in court cases?

Part of these discussions will need to anticipate and plan for any unintended negative consequences of releasing into the world technologies designed to make arms control easier. Could these detection algorithms and other monitoring tools be undermined,

Image 4. T4T ammunition annotation platform. © T4T 2022



counteracted or abused? How can we ensure that illicit arms data, or other sensitive data, is rendered sufficiently secure? Now is the time to raise these important questions, as well.

Arguably, our collective attention should focus on applications that can increase efficiency, lower costs, and support states with the greatest needs in their fight against illicit arms and ammunition and their misuse. This means looking not only at new tech solutions for the arms and ammunition manufacturing sector, but also those that address the more than one billion small arms and light weapons plus their ammunition already in circulation, the significant majority of which are outside the control of national authorities.[6]

Conclusions

As BMS8 made clear, the arms control community remains focused on reacting to threats that specific technological advances in weapons present for international agreements, such as the PoA/ITI, rather than on harnessing new technology for advancing arms control objectives. A mindset change is needed that shifts the focus from plugging gaps to ramping up and applying emerging capacities for the control of both existing pools of illicit weapons and next-generation ones.

Achieving this mindset change will require the active engagement of technology experts working in partnership with arms control experts, national authorities, and private industry, and across political processes that are currently isolated from one another. New technology applications that combine computer vision, OCR, and machine learning will allow the identification and documentation of not only small arms and light weapons, but also ammunition, larger conventional weapons, prohibited explosive ordnance items, improvised explosive devices, and other objects. These new technology applications are clearly also highly relevant to ongoing discussions on autonomous weapons systems.

To advance these and other priorities, T4T aims to convene and coordinate new tech and arms control professionals for consultations on specific emerging technologies and relevant political processes. While supporting the development of joint initiatives and proposals for specific projects to enhance the use of new tech in arms control should be a priority, there is also a strong need to anticipate and plan for the potential unintended negative consequences of openly disseminating new arms control technologies, and to explore modalities for using these new technologies to bridge the arms control 'digital divide' between states. While the development of new tools will require significant investment, the objective is to provide more effective solutions at minimal cost.

In the months ahead T4T will provide updates on the development of the technologies described in this Policy Brief, and will work to promote the application of new tech solutions use cases in a range of international arms control forums.

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About Tech 4 Tracing

Tech 4 Tracing (T4T) is an international, US-based non-profit working to apply new technologies to arms and ammunition control. A partnership between arms control experts and new technology professionals, T4T aims to augment the capabilities of actors involved in arms and ammunition identification and tracing globally by creating automated and accurate tools to lower the costs of doing this work, increase the number of actors who could contribute, and empower qualified actors to disrupt illicit arms and ammunition trafficking and misuse, bring perpetrators of armed violence to justice, and contribute to safer societies.

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Partners and supporters

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Notes

1 United Nations General Assembly. 2022. Report of the Eighth Biennial Meeting of States to Consider the Implementation of the Programme of Action to Prevent, Combat and Eradicate the Illicit Trade in Small Arms and Light Weapons in All Its Aspects. A/CONF.192/BMS/2022/1 of 8 July, para. 81. <https://documents.unoda.org/wp-content/uploads/2022/07/Final-report-_BMS8-unedited.pdf>

2 See BMS8 outcome document, para. 75. The first discussion of polymer and modular weapon designs and the challenges they present for ITI implementation occurred during the 2011 Meeting of Governmental Experts.

3 For more information, see <https://vframe.io/about/collaborations/t4t>.

4 The beta 9N235 detector achieves over 98 per cent F1 score on the Interlaken, a medium-difficulty staged dataset.

5 A live beta model of the 9N235 detector can be found at <https://modelzoo.vframe.io/>. The web demo uses a lightweight model and is for demo purposes only.

6 Small Arms Survey. 2020. 'Global Firearm Holdings.' 29 March. <https://www.smallarmssurvey.org/database/global-firearms-holdings>